FIG. 1A

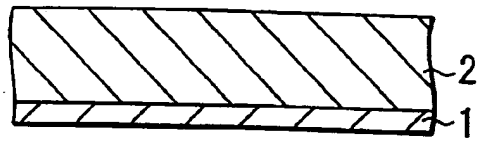


FIG. 1B

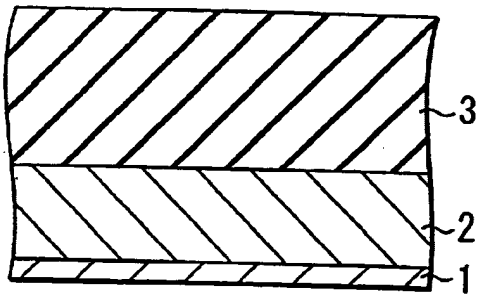


FIG. 1C

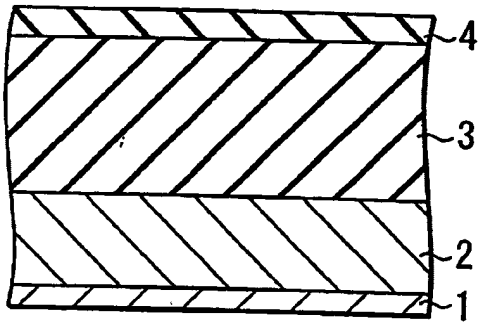


FIG. 1D

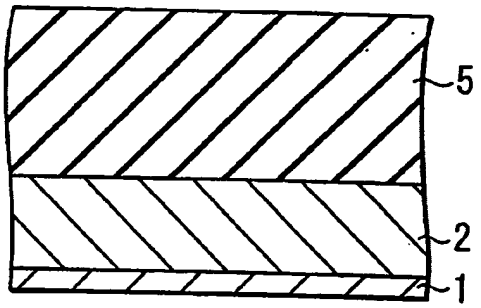
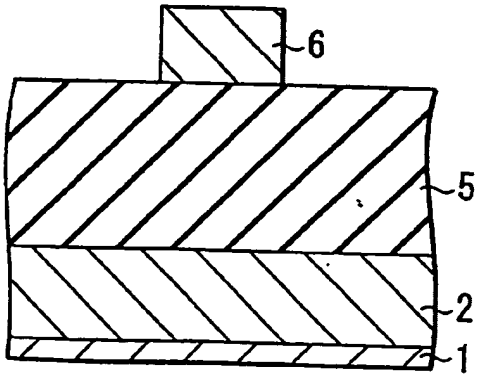


FIG. 1E



TUBULAR BULB:Cu
(WAVELENGTH:1.54056A)
TUBULAR BULB VOLTAGE:44KV
TUBULAR BULB CURRENT:250mA
GONIOMETER:WIDE-ANGLE
GONIOMETER
STEP WIDTH:0.040°
TIME FOR MEASUREMENT:0.50sec
SCANNING AXIS:2θ/θ

DIVERGENCE SLIT:1/2°
DIFFRACTION SLIT:1/2°
LIGHT RECEIVING SLIT:0.15mm
LIGHT RECEIVING SLIT OF
MONOCHROMATER:
LIGHT RECEIVING SLIT:0.45mm
θ OFFSET ANGLE:0.000°

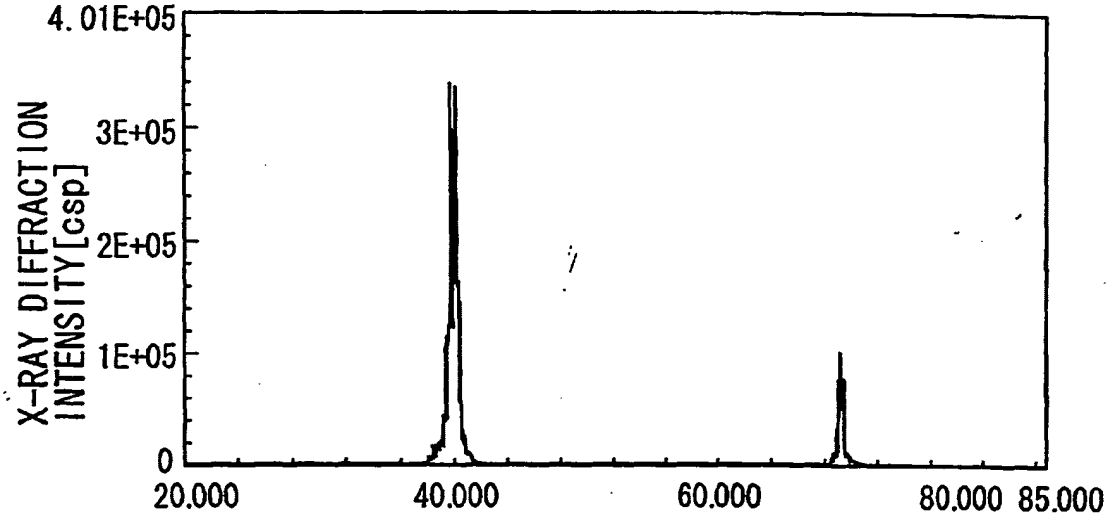


FIG.2A

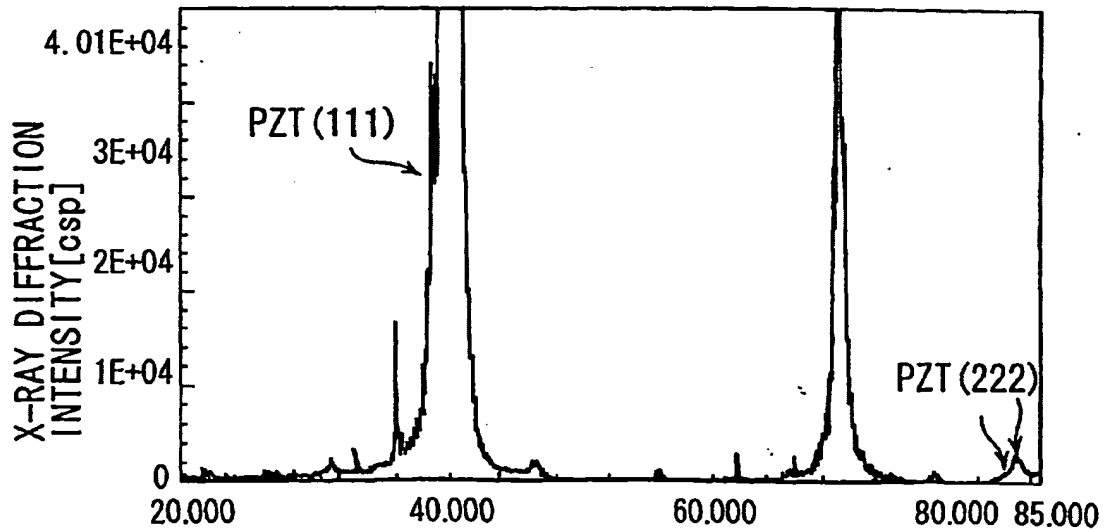


FIG.2B

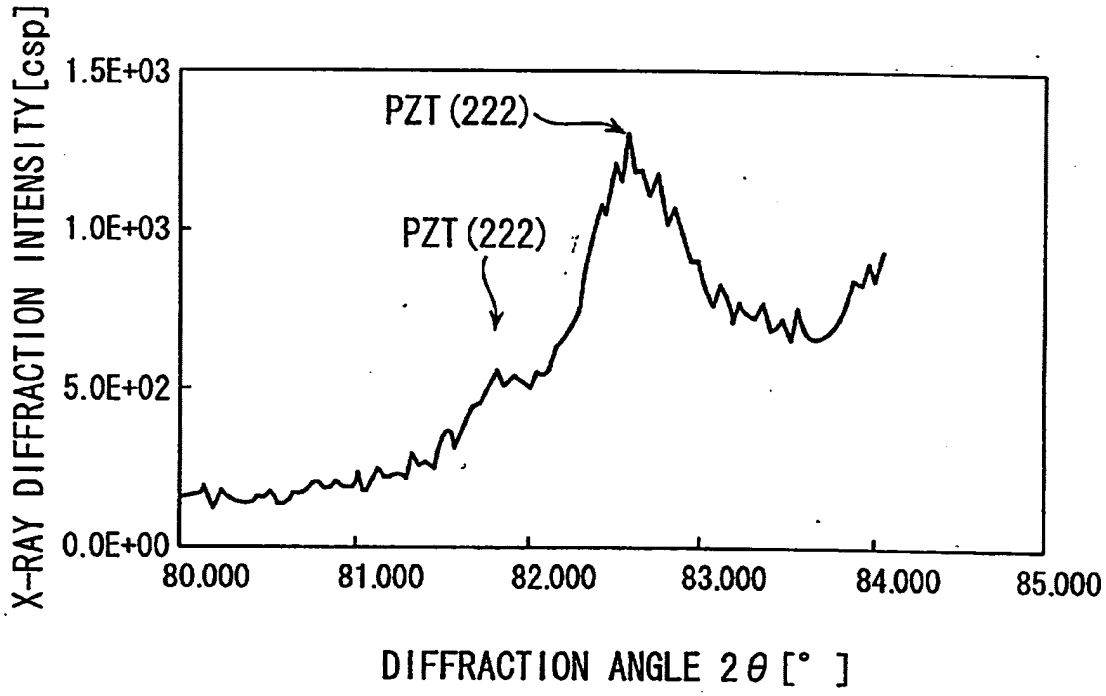

X-RAY DIFFRACTION INTENSITY [csp]
1.5E+03
1.0E+03
5.0E+02
0.0E+00
PZT (222)
PZT (222)
80.000
81.000
82.000
83.000
84.000
85.000
DIFFRACTION ANGLE 2θ [°]

FIG.2C

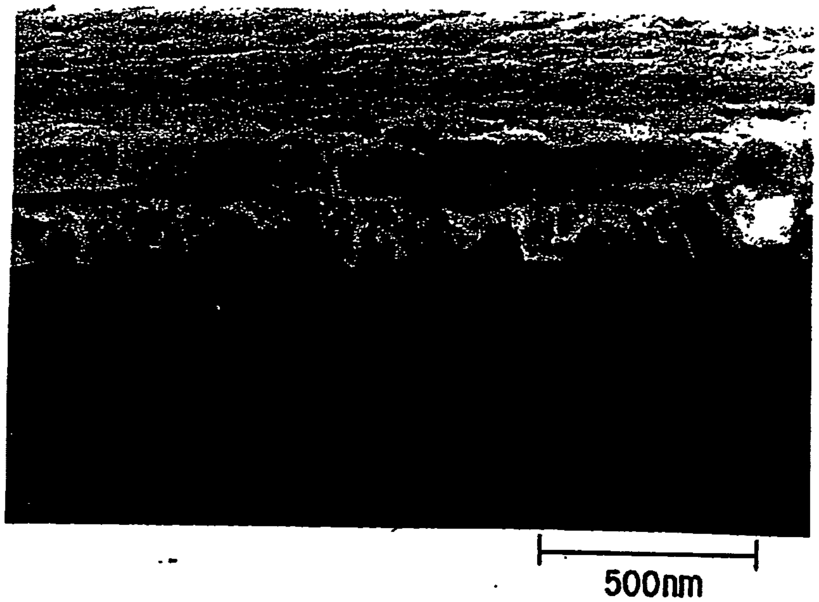


FIG. 3A

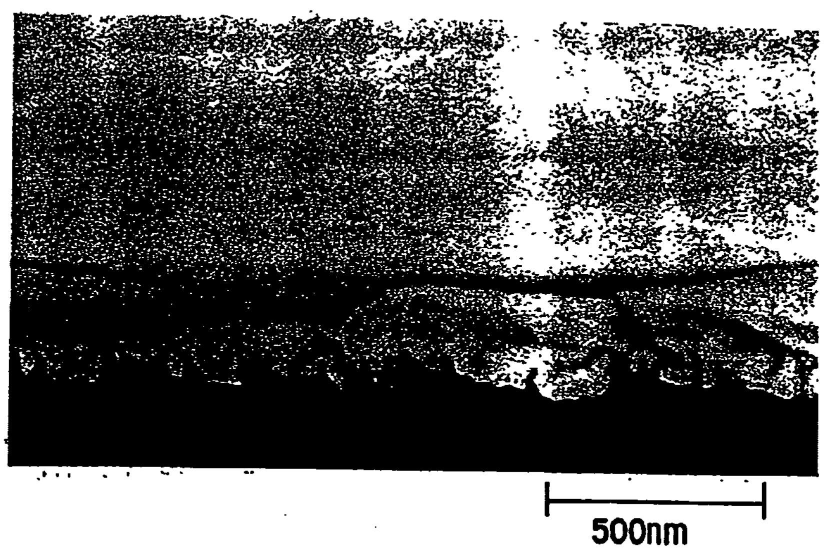


FIG. 3B

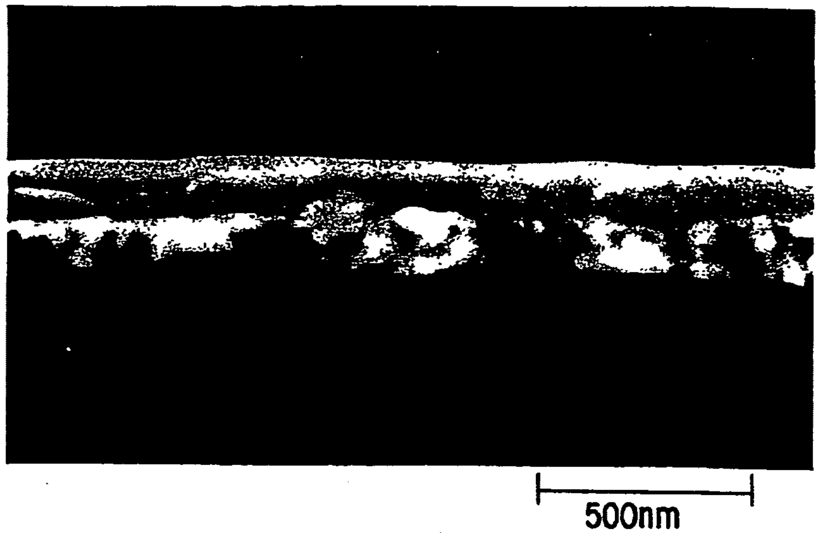


FIG. 4

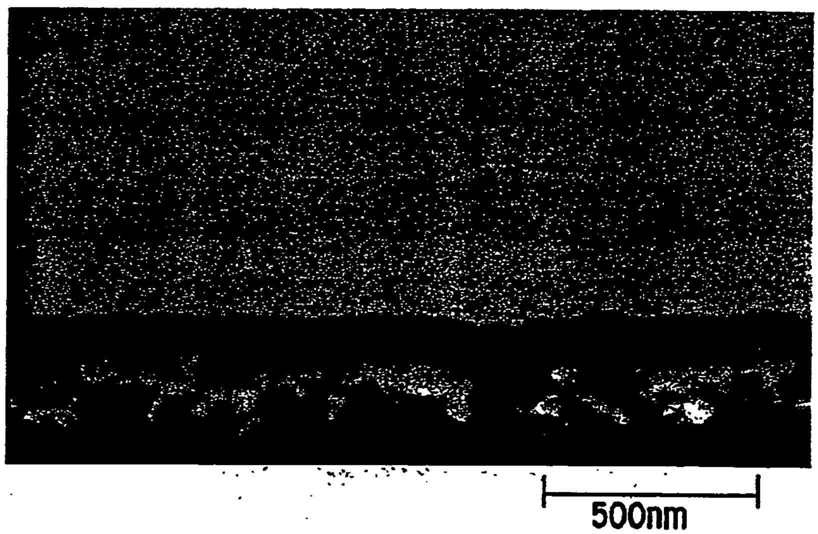


FIG. 6A

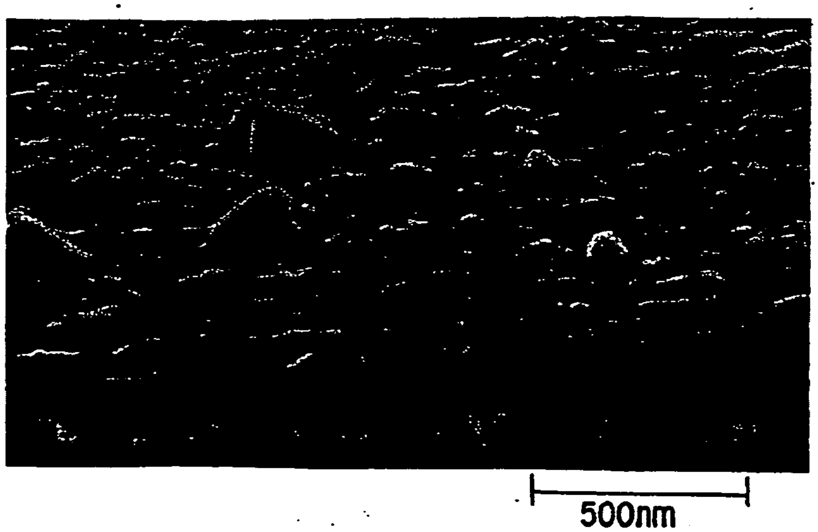


FIG. 6B

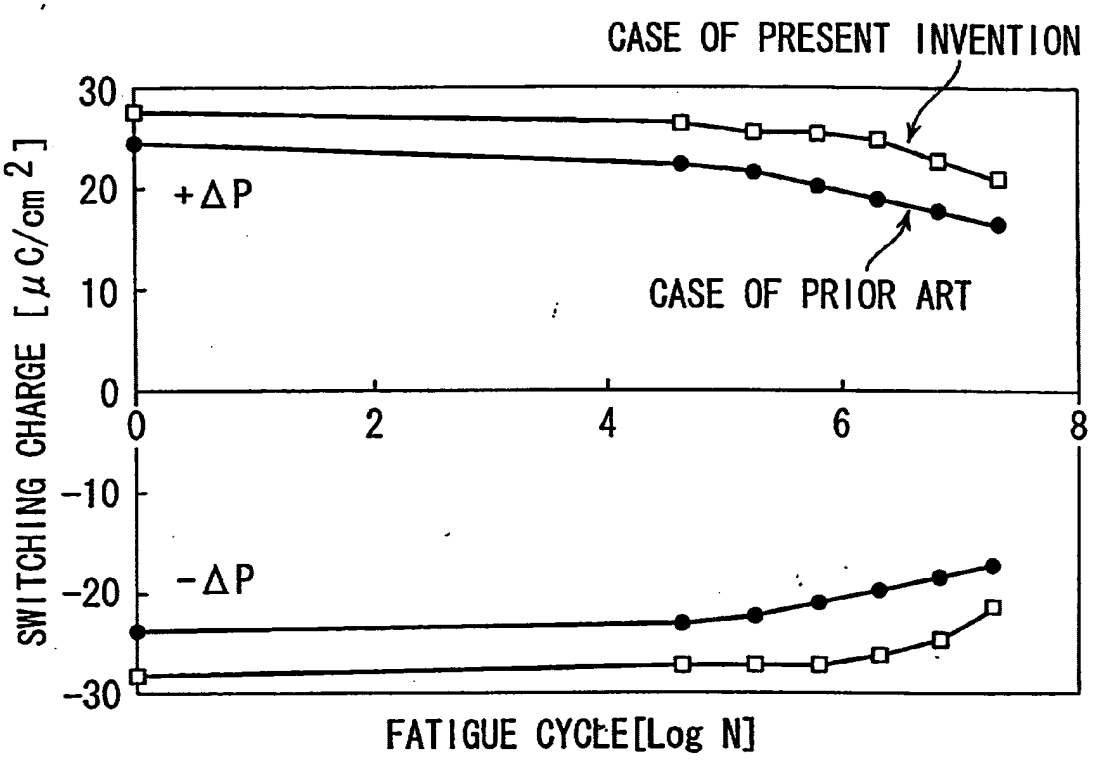

CASE OF PRESENT INVENTION
CASE OF PRIOR ART
+ΔP
-ΔP
SWITCHING CHARGE [μC/cm²]
FATIGUE CYCLE[Log N]
30
20
10
0
-10
-20
-30
0
2
4
6
8

FIG. 5

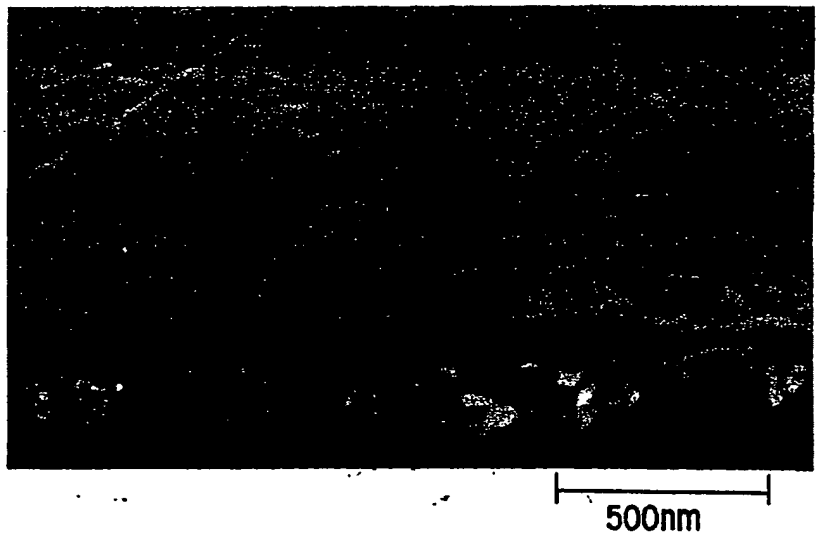


FIG. 7A

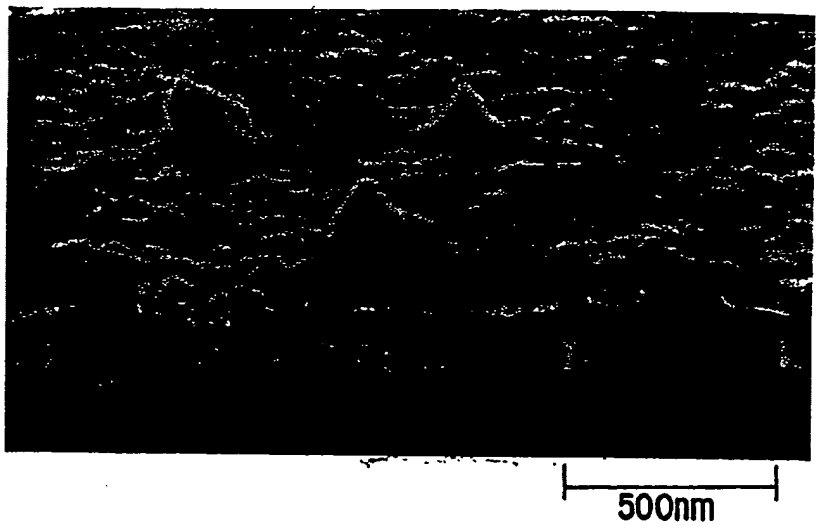


FIG. 7B

FIG. 8A

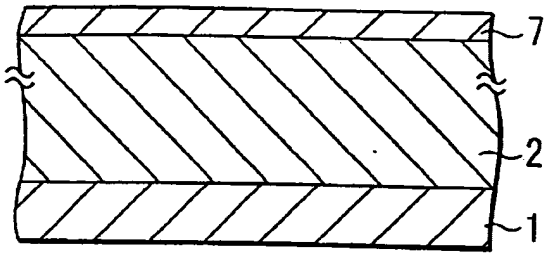


FIG. 8B

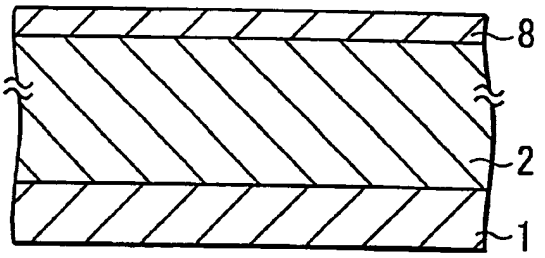


FIG. 8C

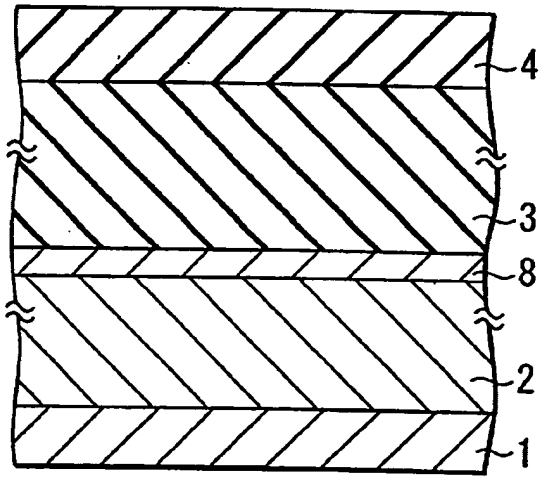
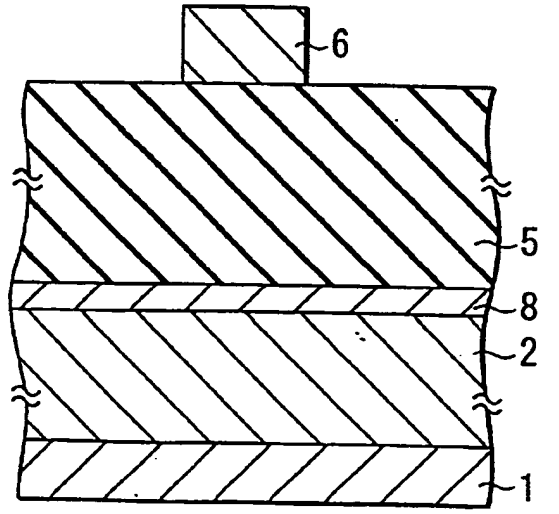


FIG. 8D



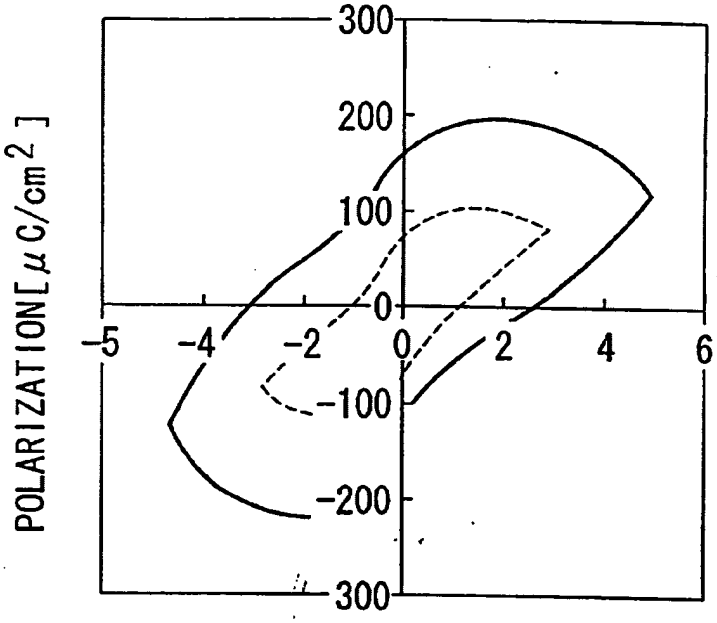

300
200
100
0
-100
-200
-300
-5
-4
-2
0
2
4
6
POLARIZATION[μC/cm²]
APPLIED VOLTAGE[V]

FIG. 9A

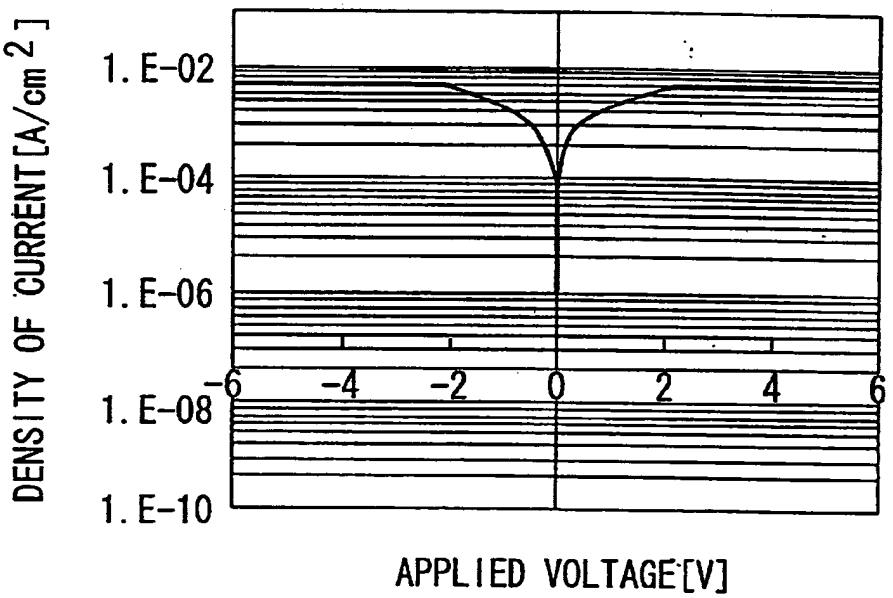

1.E-02
1.E-04
1.E-06
1.E-08
1.E-10
-6
-4
-2
0
2
4
6
DENSITY OF CURRENT[A/cm²]
APPLIED VOLTAGE[V]

FIG. 9B

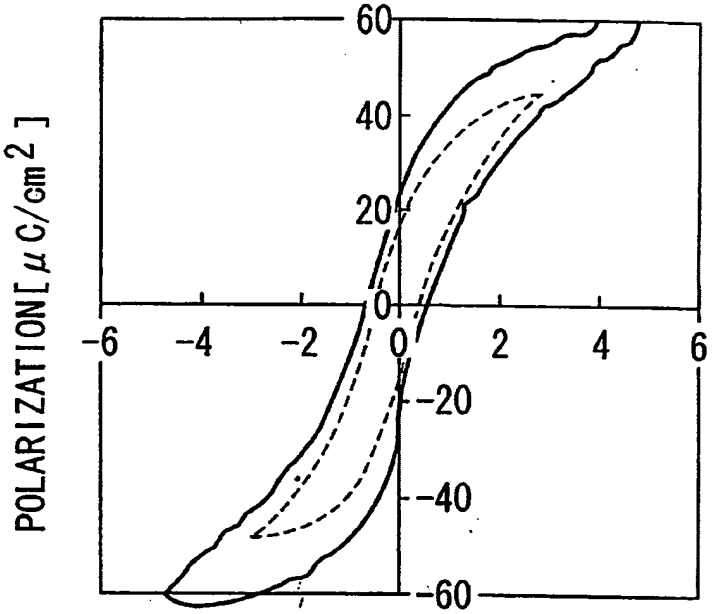


FIG. 10A

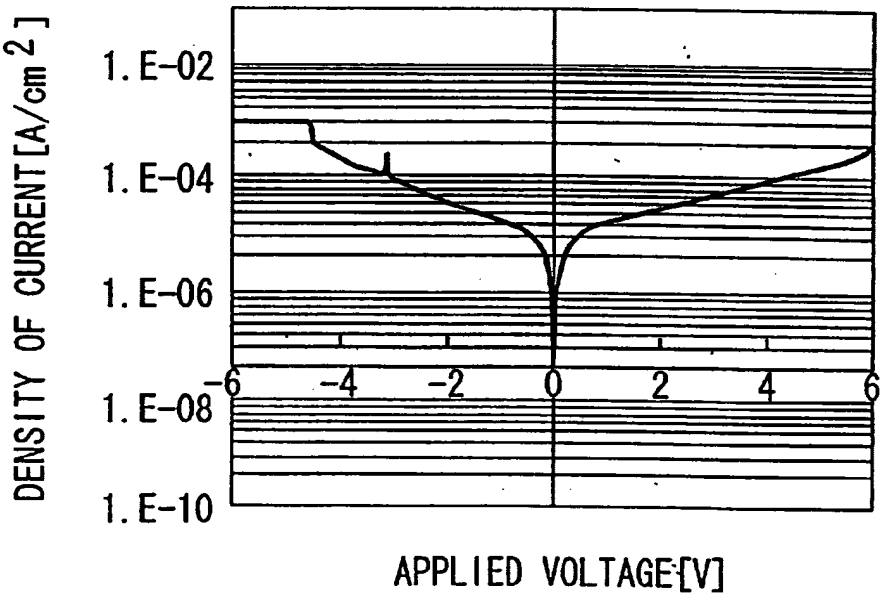


FIG. 10B

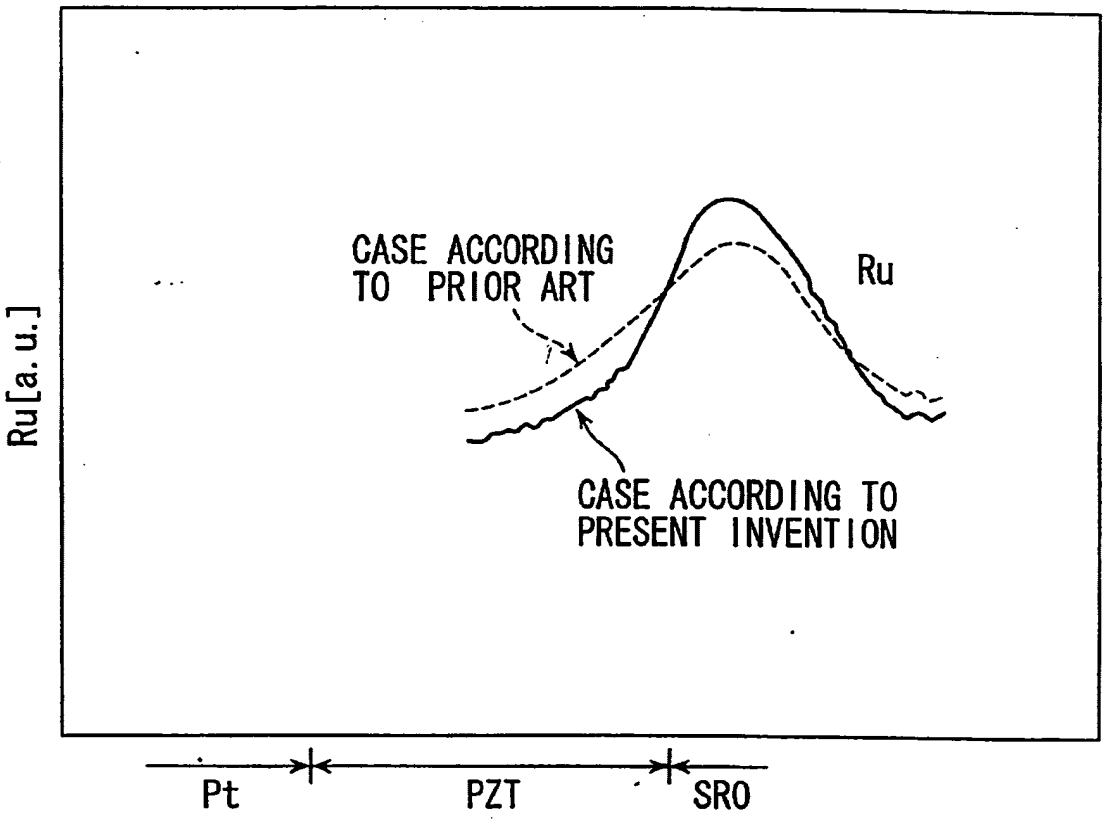

Ru[a.u.]
CASE ACCORDING TO PRIOR ART
Ru
CASE ACCORDING TO PRESENT INVENTION
Pt
PZT
SRO

FIG. 11

FIG. 12A

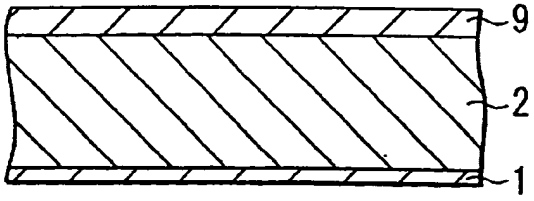


FIG. 12B

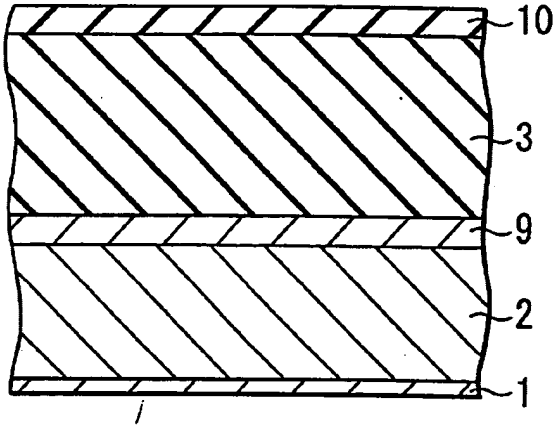


FIG. 12C

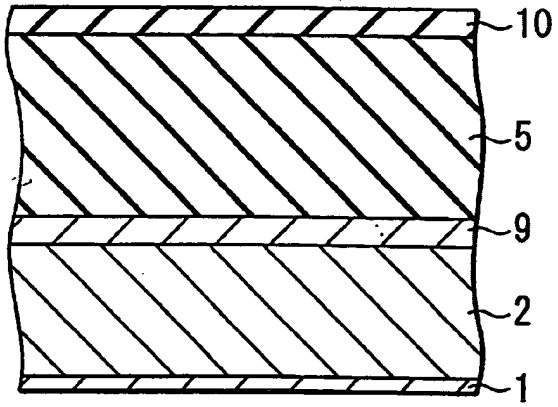
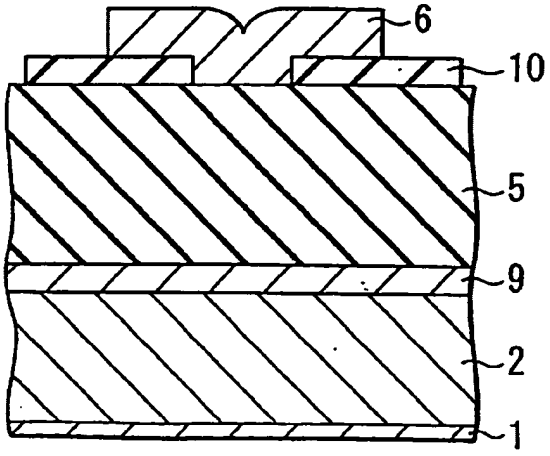


FIG. 12D



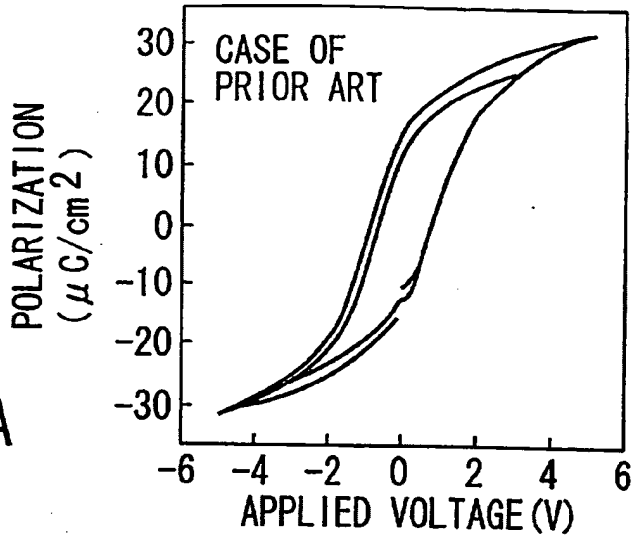


FIG. 13A

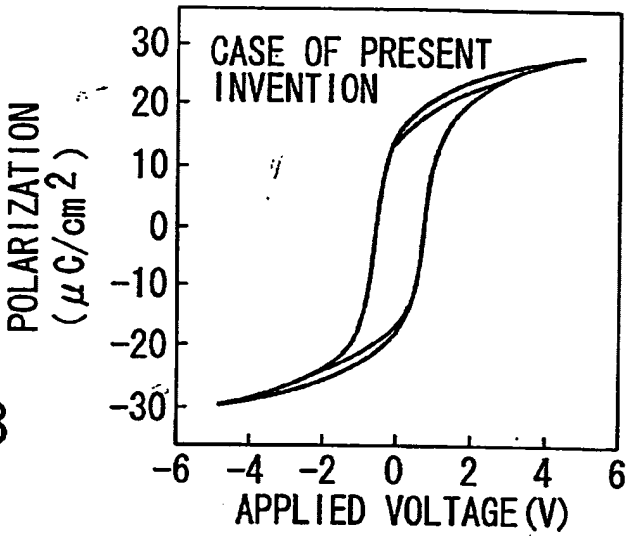


FIG. 13B

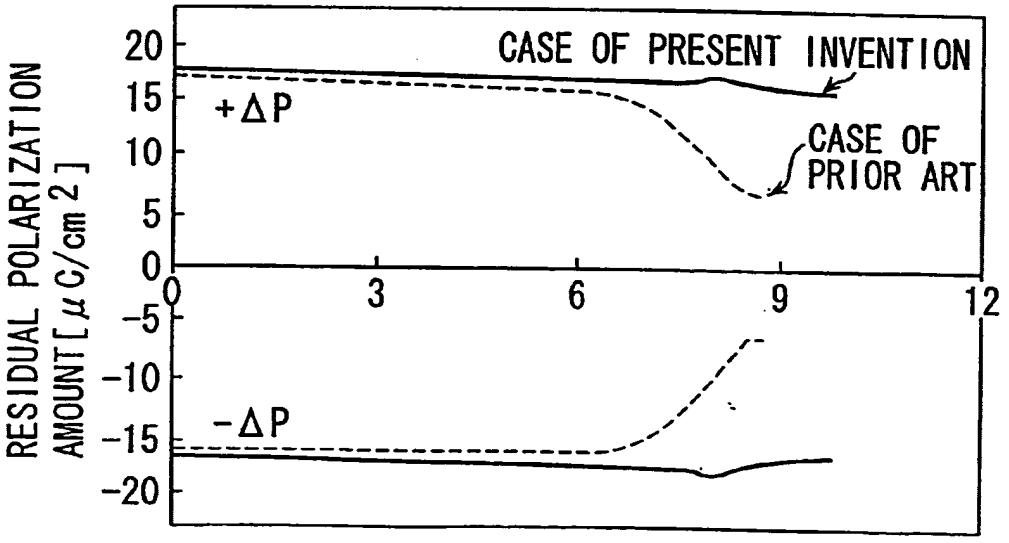


FIG. 14

FIG. 15A

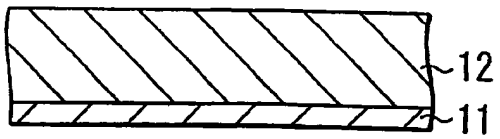


FIG. 15B

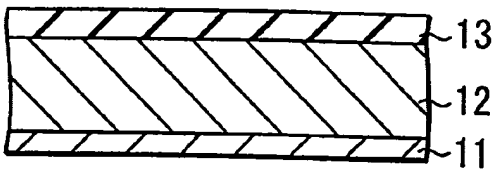


FIG. 15C

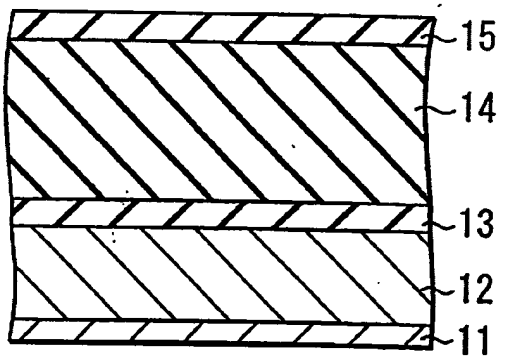


FIG. 15D

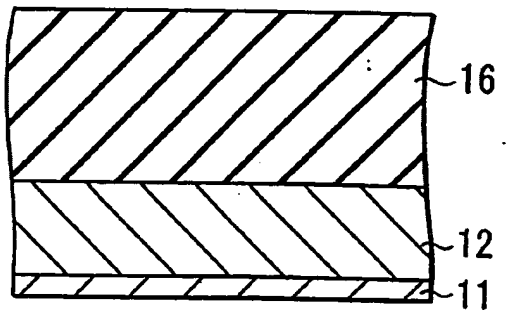


FIG. 15E

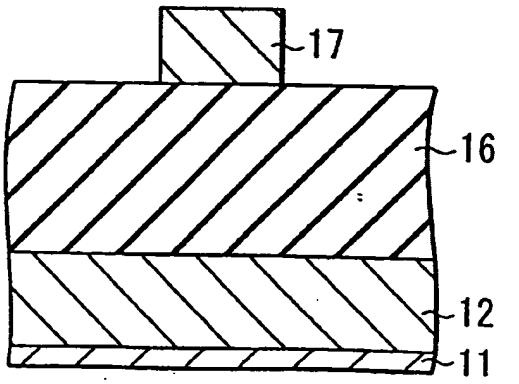


FIG. 16

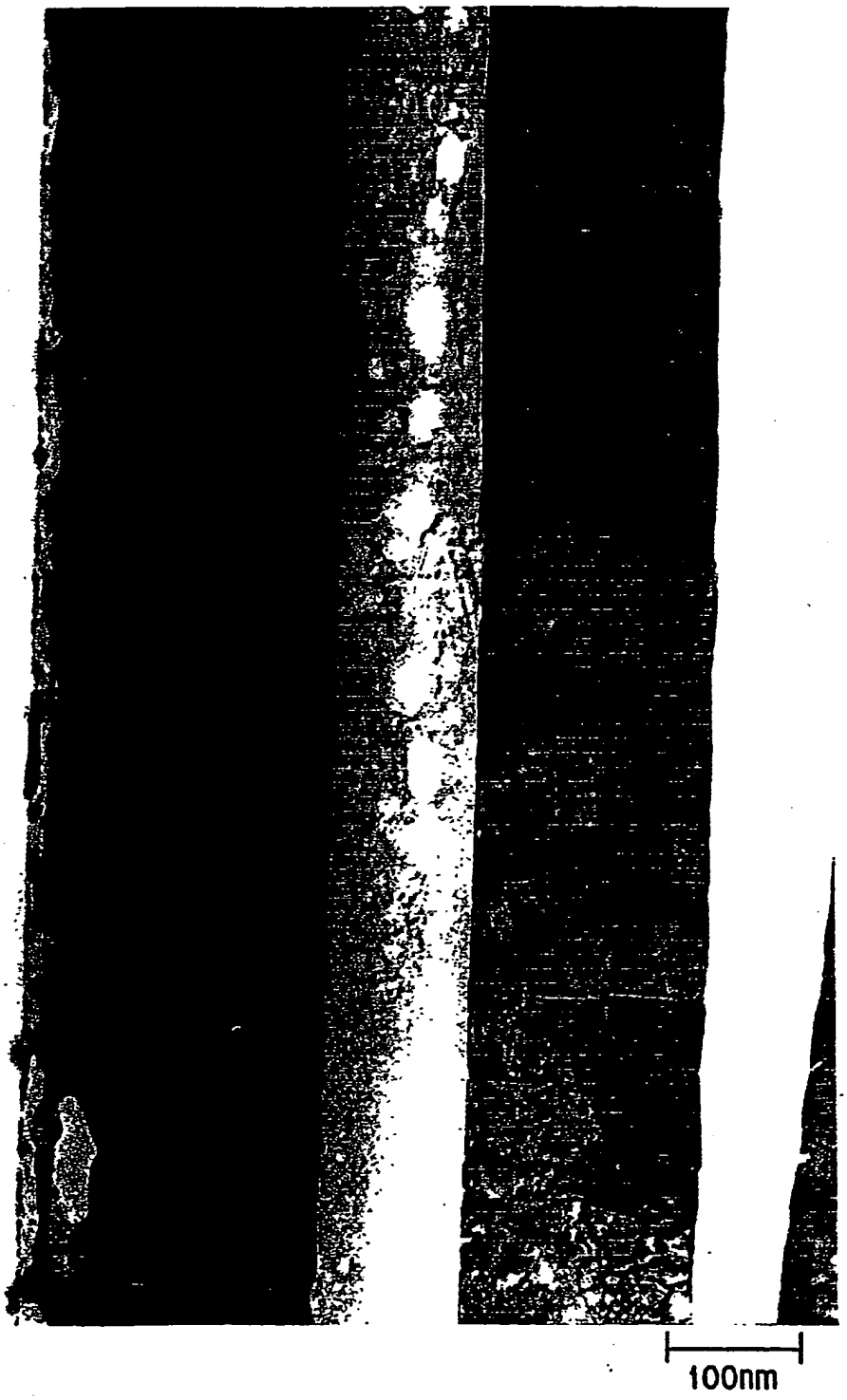
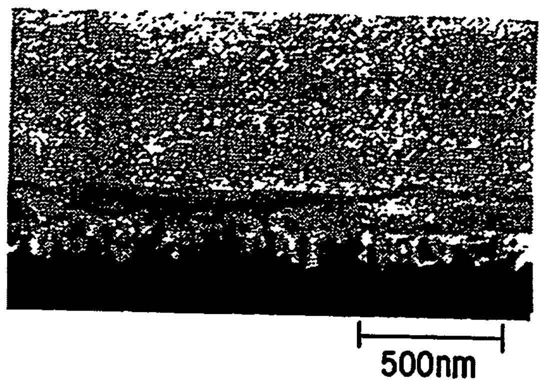
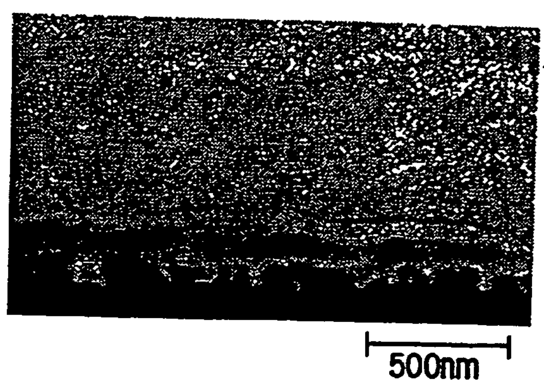


FIG.17



F I G. 18A



F I G. 18B

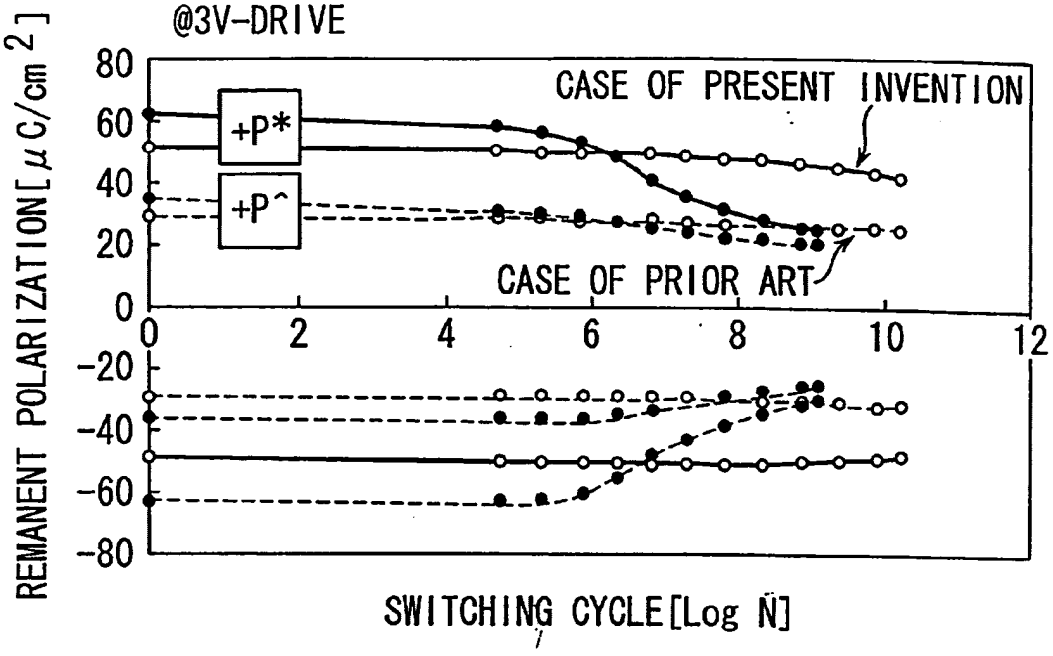


FIG. 19

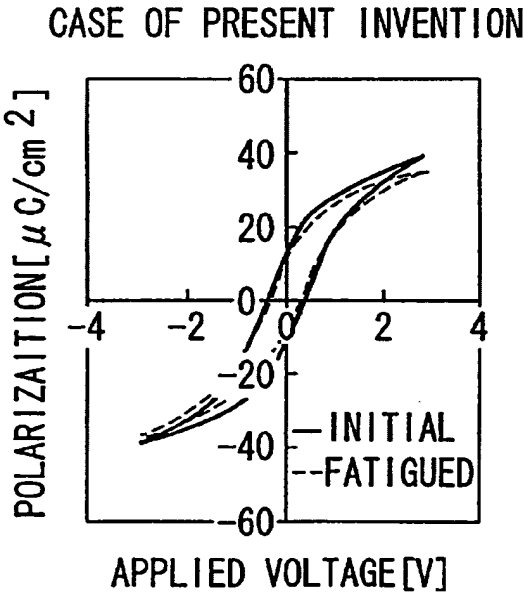


FIG. 20A

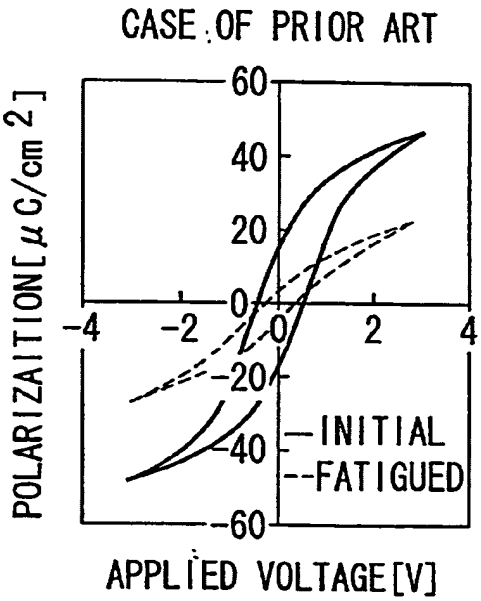


FIG. 20B

FIG. 21A

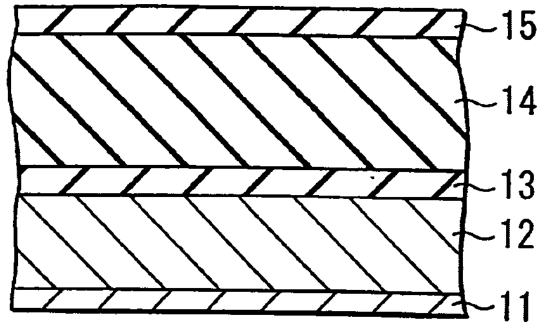


FIG. 21B

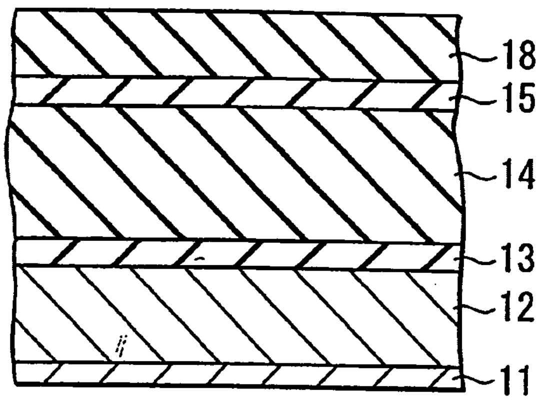


FIG. 21C

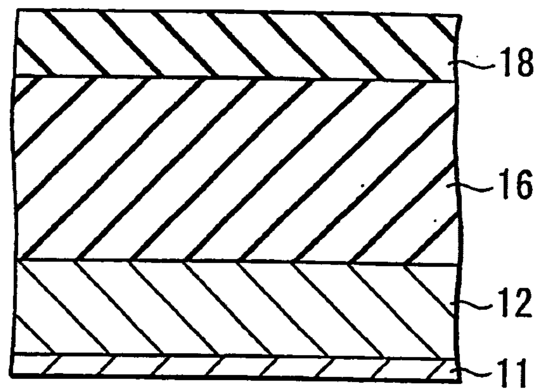
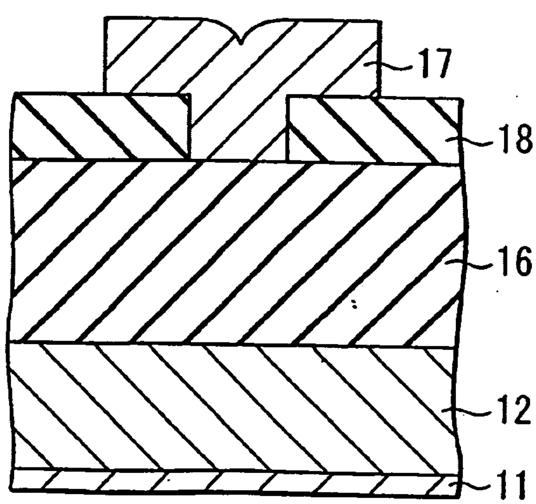


FIG. 21D



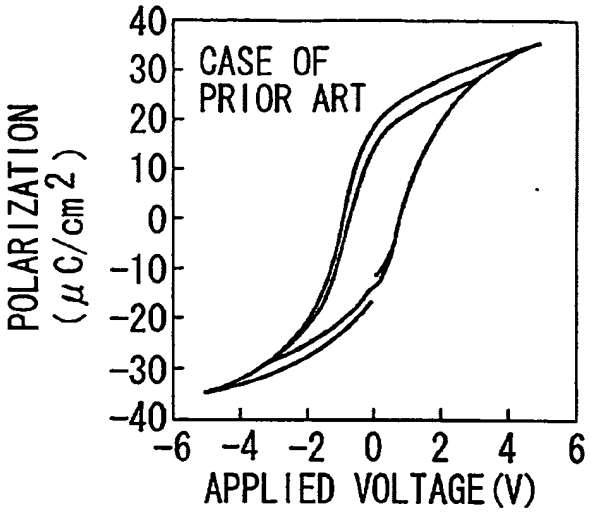


FIG. 22A

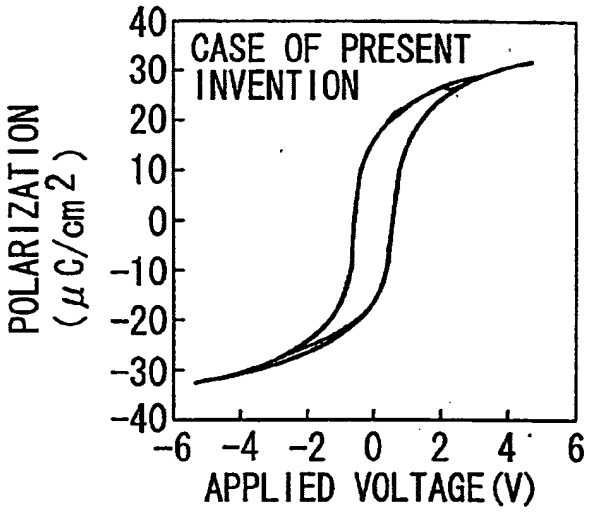


FIG. 22B

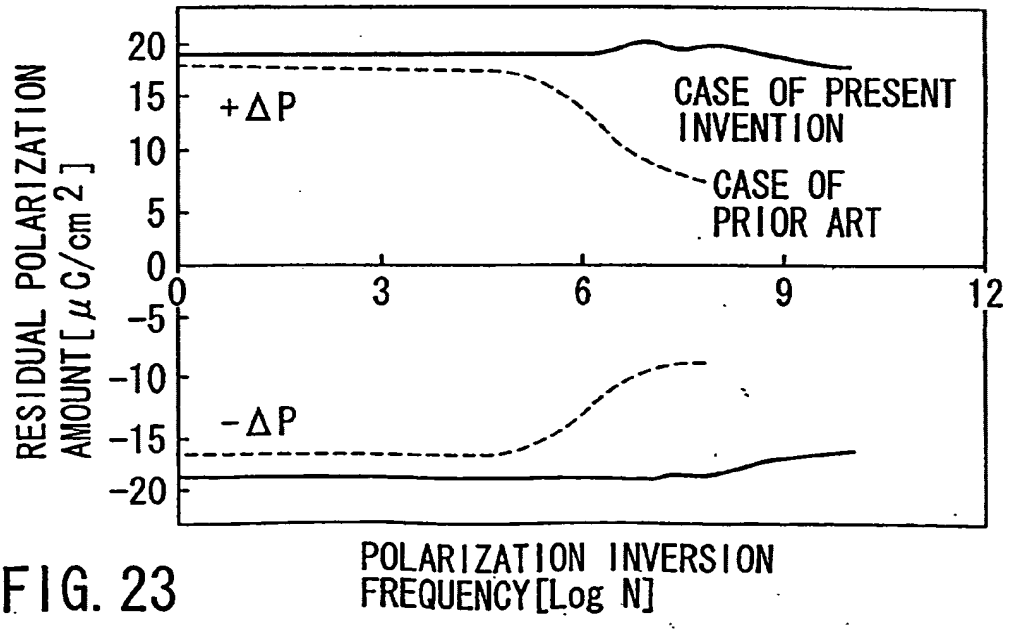


FIG. 23

TUBULAR BULB:Cu
TUBULAR BULB VOLTAGE:44KV
TUBULAR BULB CURRENT:250mA
GONIOMETER:WIDE-ANGLE GONIOMETER
STEP WIDTH:0.040°
TIME FOR MEASUREMENT :0.50sec
SCANNING AXIS:2θ/θ

DIVERGENCE SLIT:1/2°
DIFFRACTION SLIT:1/2°
LIGHT RECEIVING SLIT:0.15mm
REVOLUTION SPEED:60rpm/min
LIGHT RECEIVING SLIT OF MONOCHROMATER:
LIGHT RECEIVING SLIT:0.45mm
θ OFFSET ANGLE:0.000°

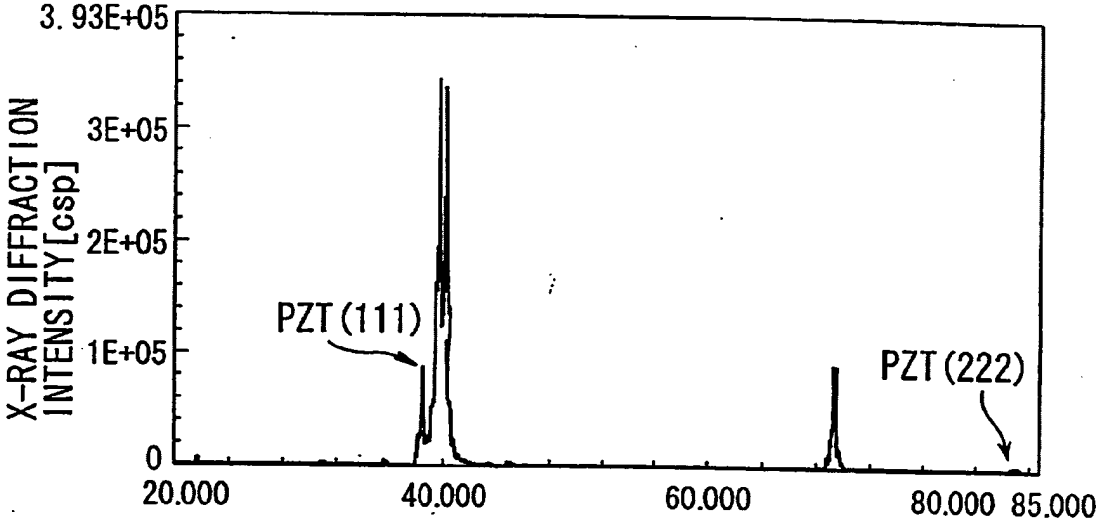


FIG. 24A

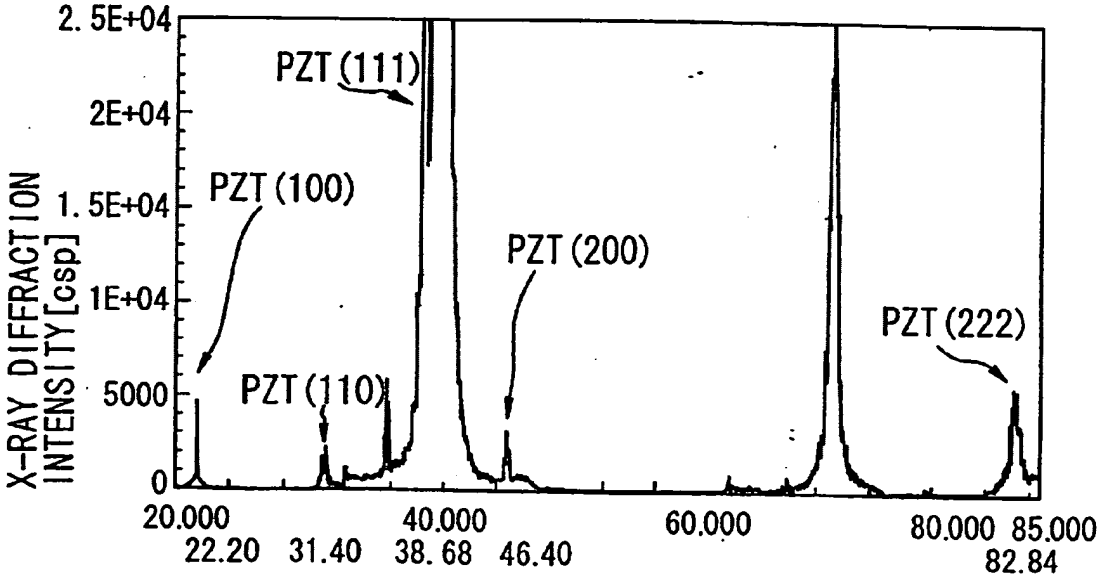


FIG. 24B

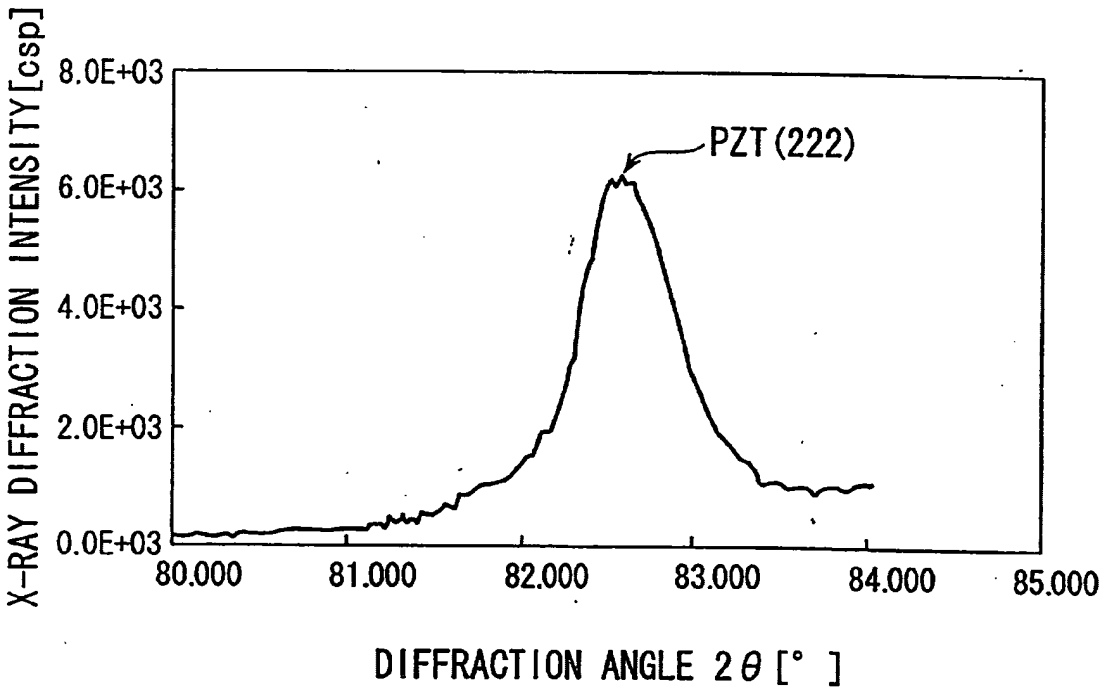

X-RAY DIFFRACTION INTENSITY[csp]
8.0E+03
6.0E+03
4.0E+03
2.0E+03
0.0E+03
PZT(222)
80.000
81.000
82.000
83.000
84.000
85.000
DIFFRACTION ANGLE 2θ[°]

FIG. 24C

Y-AXIS:P(POLARIZATION)
X-AXIS:V(APPLIED VOLTAGE)
Pr+:POINT OF INTERSECTION OF HYSTERESIS CURVE WITH POSITIVE SIDE OF Y-AXIS
Pr-:POING OF INTERESECTION OF HYSTERSIS CURVE WITH NEGATIVE SIDE OF Y-AXIS

$2Pr = Pr+ - Pr-$

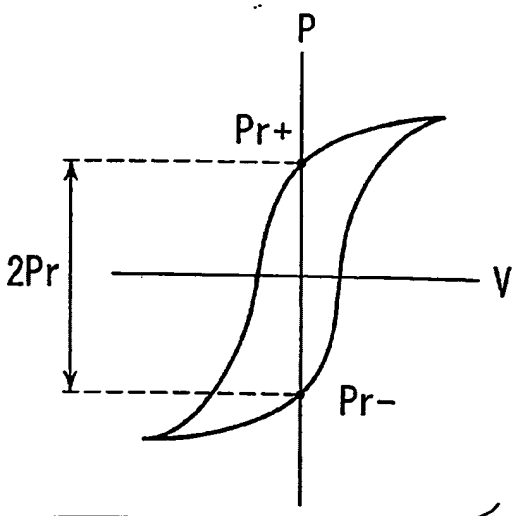


FIG. 25

Psat.+:POSITIVE SATURATION POLARIZATION AMOUNT

Psat.-:NEGATIVE SATURATION POLARIZATION AMOUNT

$$\text{RECTANGULARITY RATIO} = \frac{Pr+}{Psat.+} \,\&\, \frac{Pr-}{Psat.-}$$

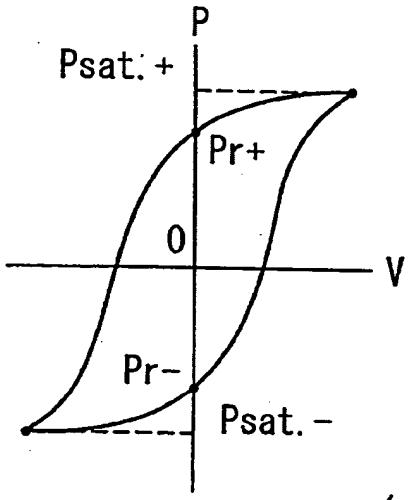


FIG. 26